

Toward Upper-Air Observations for Climate

Purpose of this document: To describe activities, planned for the next 12-18 months, designed to provide the scientific and technical basis for upper-air observations to meet climate requirements. The overarching long-term goal is the deployment and operation of a global upper-air observing system that both satisfies climate needs and is integrated with other earth observations. This goal is fully consistent with the Global Climate Observing System (GCOS) goals to specify and plan an upper-air reference network by 2005 and to begin to implement it by 2009, as stated in its draft Implementation Plan (Action A19).

Background and Motivation: Upper-air observations are required for climate monitoring, prediction, modeling, and research. Scientists have for decades relied on observations of temperature, humidity and winds from the operational radiosonde networks. More recently, satellite observations, offering vastly greater spatial coverage, have also been exploited for climate studies. Over the past decade, the inadequacy of those observing systems to fully meet climate requirements has become increasingly clear and the subject of study and scientific debate. Several proposals have been put forward for improved upper-air observations for the 21st century to meet various climate requirements. However, a comprehensive, scientifically-based set of requirements for upper-air observations for climate has not been developed, and this gap has hindered the incorporation of climate considerations in planning future upper-air observing systems.

Step I - Workshop to Define Climate Requirements for Upper-Air: NOAA and the GCOS Secretariat will co-sponsor a workshop, to be held in Boulder in early 2005, to define climate requirements for upper air observations. This workshop will bring together scientists with expertise in the full spectrum of climate activities that require upper-air sounding observations, including: monitoring and detecting climate variability and change; climate prediction on seasonal, interannual, and longer time scales; climate modeling, including model evaluation and parameterization; climate process studies including feedbacks; reanalysis activities; and satellite studies, including calibration of satellite retrievals and radiative transfer studies.

The product of this workshop will be a set of quantitative requirements (vertical, horizontal, and temporal resolution, long-term stability, accuracy, etc.) in a form consistent with existing NOAA and GCOS requirements standards. Both the NOAA and GCOS programs recognize that clear, quantitative requirements statements are a first step in defining and implementing observing systems. Within NOAA this activity falls under the purview of the NOAA Observing System Architecture, which parallels WMO's Rolling Requirements Review. These activities will be represented at the workshop to ensure that the requirements are clearly articulated and complete.

The joint sponsorship of this workshop is based on the recognition that climate science is international and that a global network will require international cooperation and coordination. Indeed, the GCOS Atmospheric Observing Panel for Climate has formed a Working Group on Reconciliation of Surface and Free Atmosphere Temperature Trends

(AOPC/WG-TT), whose first charge is to consider the design and implementation of a Reference Upper Air Network, and whose members bring both scientific expertise and an international perspective to the issue.

Integration of Requirements: Both NOAA and GCOS, and the emerging Global Earth Observation System of Systems (GEOSS) program, explicitly recognize that climate observing systems are not stand-alone. NOAA envisions an Integrated Upper Air Observing System (IUAOS), and GCOS has called for a Reference Upper Air Network of climate sites providing highly-detailed and accurate observations for robust calibration/validation of more spatially-complete observations. In both cases, the requirements of the climate community will be integrated with those of other users of upper-air observations, to allow evaluation of the full suite of requirements and development of optimized and complementary observing systems, including in situ soundings, satellite observations, and possibly airborne and ground-based, upward-looking remote sensors.

Step II - Examination of Technical Options to Meet Requirements: Following the requirements workshop, in mid-2005, a second workshop should examine the potential instruments, platforms, and deployments that are available, or could be developed, to meet the stated requirements, including rough cost estimates for each option. Because the participants in such a workshop would likely come from academia, governments and the private sector, and from many nations, and because of WMO's long history of interaction with instrument community, it is hoped that WMO could convene this workshop, with NOAA cooperation.

The goal of the meeting would be to consider a variety of proposed technologies and select a small set of options that best meet climate requirements for upper-air observations. These options would then be presented to relevant agencies for their consideration, more detailed analysis, and eventual implementation. The focus of this activity would likely be optimizing and improving in situ sounding technologies, with the recognition that these would complement, and support, satellite observations.

Involvement of the Scientific Community: A key aspect of this activity is that the results (requirements, technical options, and the eventual observing system) should be widely vetted and supported by the scientific community. Therefore, the participation in the workshops should be as open as possible, and all preparatory documentation and workshop reports should be widely circulated. The US GCOS Program Office and NOAA Office of Climate Observations will develop and maintain a website for easy access to workshop information (a URL web address will be forthcoming). Comments on draft workshop reports will be solicited via the website and by direct (email) and indirect communication (listserves, professional publications) with the scientific community.